

What is claimed is:

- 1        1. An integrated circuit package, comprising:
  - 2              a semiconductor die electrically connected to a substrate;
  - 3              a heat sink having a portion thereof exposed to the surroundings of said
  - 4        package;
  - 5              a thermally conductive element thermally coupled with and interposed
  - 6        between both said semiconductor die and said heat sink, wherein said thermally
  - 7        conductive element does not directly contact said semiconductor die; and
  - 8              an encapsulant material encapsulating said thermally conductive element
  - 9        and said heat sink such that said portion of said heat sink is exposed to the surroundings
  - 10       of said package.
- 1        2. The integrated circuit package of claim 1, wherein said thermally
- 2        conductive element is substantially shaped as a right rectangular solid.
- 1        3. The integrated circuit package of claim 1, wherein a top portion and a side
- 2        portion of said heat sink are exposed to the surroundings of said package.
- 1        4. The integrated circuit package of claim 1, wherein said thermally
- 2        conductive element is made of a material from the group consisting of alumina,
- 3        aluminum nitride, beryllium oxide, ceramic material, copper, diamond compound, and
- 4        metal.
- 1        5. The integrated circuit package of claim 1, wherein said integrated circuit
- 2        package is a ball grid array integrated circuit package.

1           6.       The integrated circuit package of claim 1, further comprising an interface  
2       element interposed between said thermally conductive element and said semiconductor  
3       die.

1           7.       The integrated circuit package of claim 6 wherein said interface element is  
2       made of a polymeric material.

1           8.       The integrated circuit package of claim 1, wherein a distance between said  
2       semiconductor die and said thermally conductive element is about five (5) mils or less.

1           9.       The integrated circuit package of claim 1, wherein said semiconductor die  
2       is electrically connected to said substrate by direct chip attachment.

1           10.      An integrated circuit package, comprising:  
2                    a semiconductor die electrically connected to a substrate;  
3                    a heat sink having a portion thereof exposed to the surroundings of said  
4       package;

5                   means for thermally coupling said semiconductor die with said heat sink  
6       to dissipate heat from said semiconductor die to the surroundings of said package,  
7       wherein said means for thermally coupling is interposed between said semiconductor die  
8       and said heat sink but does not directly contact said semiconductor die; and  
9                   means for encapsulating said thermally conductive element and said heat  
10      sink such that said portion of said heat sink is exposed to the surroundings of said  
11      package.

1           11.      An integrated circuit package, comprising:  
2                    a substrate comprising:

3                   an upper face with an electrically conductive trace formed thereon;

4       and

5                   a lower face with a plurality of solder balls electrically connected  
6       thereto, wherein said trace and at least one of said plurality of solder balls are electrically  
7       connected;

8                   a semiconductor die mounted on said upper face of said substrate, wherein  
9       said semiconductor die is electrically connected to said trace;

10                  a heat sink having a top portion and a plurality of side portions;

11                  a thermally conductive element thermally coupled to but not in direct  
12       contact with said semiconductor die, wherein said thermally conductive element is  
13       substantially shaped as a right rectangular solid, is interposed between said  
14       semiconductor die and said heat sink, and is attached to said heat sink; and  
15                  an encapsulant material formed to encapsulate said upper face of said  
16       substrate, said semiconductor die, said thermally conductive element and substantially all  
17       of said heat sink except said top portion and said side portions of said heat sink.

1           12.   The integrated circuit package of claim 11, further comprising an interface  
2       element interposed between said thermally conductive element and said semiconductor  
3       die.

1           13.   The integrated circuit package of claim 12, wherein said interface element  
2       is in direct contact with said heat sink.

1           14.   The integrated circuit package of claim 12, wherein said interface element  
2       is made of a polymer.

1        15. The integrated circuit package of claim 11, wherein said semiconductor  
2 die is mounted on said upper face of said substrate by direct chip attachment.

1        16. The integrated circuit package of claim 11, wherein a distance between  
2 said semiconductor die and said thermally conductive element is about five (5) mils or  
3 less.

1        17. The integrated circuit package of claim 11, wherein said thermally  
2 conductive element is made of a material from the group consisting of alumina,  
3 aluminum nitride, beryllium oxide, ceramic material, copper, diamond compound, and  
4 metal.

1        18. The integrated circuit package of claim 11, wherein said top portion of  
2 said heat sink comprises a plating.

1        19. The integrated circuit package of claim 18, wherein said plating is made of  
2 nickel.

1        20. The integrated circuit package of claim 1, wherein said integrated circuit  
2 package is a ball grid array integrated circuit package.

1        21. An integrated circuit package, comprising:  
2              a substrate comprising:  
3                  means for electrically interconnecting a semiconductor die; and  
4                  means for exchanging electrical signals with an outside device;  
5              a semiconductor die attached and electrically connected to said substrate  
6              by attachment means;  
7              a heat sink having means for dissipating thermal energy to the  
8              surroundings of said package;

9               means for thermally coupling said semiconductor die to said heat sink to  
10      dissipate heat from said semiconductor die to the surroundings of said package, wherein  
11      said means for thermally coupling is interposed between said semiconductor die and said  
12      heat sink but does not directly contact said semiconductor die; and  
13               means for encapsulating said semiconductor die, said thermally  
14      conductive element and said heat sink such that a portion of said heat sink is exposed to  
15      the surroundings of said package but is substantially encapsulated.

1               22.     A method of manufacturing an integrated circuit package, comprising:  
2               installing a carrier onto an upper surface of a substrate, wherein said  
3      carrier defines a cavity;  
4               attaching a semiconductor die to said upper surface of said substrate  
5      within said cavity of said carrier;  
6               aligning an assembly over said semiconductor die, wherein said assembly  
7      comprises a heat sink and a thermally conductive element;  
8               resting said assembly on said carrier such that said thermally conductive  
9      element does not directly contact said semiconductor die; and  
10         encapsulating said cavity to form a prepackage such that a portion of said  
11      heat sink is exposed to the surroundings of said package.

1               23.     The method of claim 22, wherein said assembly is rested on said carrier  
2      such that said thermally conductive element and said semiconductor die are separated by  
3      a distance of about five (5) mils or less.

1               24.     The method of claim 22, wherein said attaching said semiconductor die to  
2      said upper surface of said substrate is by a direct chip attachment.

1        25. The method of claim 22, further comprising singulating said prepackage to  
2 form said package, wherein a top portion and a side portion of said heat sink are exposed  
3 to the surroundings of said package.

1        26. A method of manufacturing an integrated circuit package, comprising:  
2              installing a carrier onto a substrate;  
3              attaching a semiconductor die to said substrate;  
4              aligning an assembly over said semiconductor die, wherein said assembly  
5 comprises a heat sink and a thermally conductive element;  
6              resting said assembly on said carrier such that said thermally conductive  
7 element does not directly contact said semiconductor die; and  
8              encapsulating said thermally conductive element and said heat sink such  
9 that a portion of said heat sink is exposed to the surroundings of said package.